



IMF Working Paper

The Global Financial Crisis and its Impact on the Chilean Banking System

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Abstract

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This paper explores how the global turmoil affected the risk of banks operating in Chile, and provides evidence that could help strengthen work on vulnerability indicators and off-site supervision. The analysis is based on the study of default risk codependence, or CoRisk, between Chilean banks and global financial institutions. The results suggest that the impact of the global financial crisis was limited, inducing at most a one-rating downgrade to banks operating in Chile. The paper concludes by assessing government measures aimed at reducing systemic risk in the domestic banking sector and the recommendations to allocate SWF assets to domestic banks.

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I. INTRODUCTION

Financial systems in Latin America have not been immune to the ongoing financial turmoil. The situation has been brought about by the large presence of foreign-owned institutions and substantial cross-border claims. In particular, the crisis has highlighted the significant degree of interconnectedness and risk codependence among financial institutions, a development brought about by direct sources of exposure, such as interbank borrowing, and indirect sources of exposure, such as those related to common business practices like wholesale funding.

Chile, as other open emerging market economies with highly integrated financial systems and capital markets, has been affected by developments in global financial markets. (Banco Central de Chile, 2008a, 2008b). While the financial system has remained resilient to the significant shocks experienced since September 2008, the Chilean authorities took several measures to minimize domestic disruptions and preserve stable conditions in the domestic financial system. These measures included the flexibilization of reserve requirements, swap lines, as well as government auctions of foreign currency denominated deposits for domestic banks. In addition, the Advisory Committee on Sovereign Wealth Funds (SWF) has put forward a recommendation that domestic banks be eligible institutions for SWF deposits, reflecting in part heightened risks in foreign financial institutions.

The analysis below explores how the global turmoil affected the risk of banks operating in Chile, and provides evidence that could help strengthen work on vulnerability indicators and off-site supervision. In addition, it provides a background framework to assess government measures aimed at reducing systemic risk and default codependence (or corisk) as well as the recommendations to allocate SWF assets to domestic banks.

II. A FIRST GLIMPSE ON THE POTENTIAL EXPOSURE TO FOREIGN BANKS

Foreign bank claims on the domestic economy are one important source of interconnectedness and direct exposure to shocks affecting the global banking system. BIS banking data shows that foreign bank claims on Chile, measured as percent of the recipient's country GDP, are higher than those on other emerging market countries in Latin America and elsewhere, reflecting the openness of the country's financial system (Table 1).² The exception are Eastern European countries, where foreign bank claims are substantial following the wave of acquisitions by Western European banks, especially those based in Austria and Germany.

² Explain differences between cross-border and consolidated, and the notion of immediate borrower basis.

Table 1. Foreign banks' claims on selected emerging market countries
(in percent of GDP)

	Cross border 1/		Consolidated 2/	
	2007	2008	2007	2008
Czech Republic	24.5	22.9	89.6	81.1
Hungary	51.1	60.6	84.9	99.6
Poland	22.6	22.4	49.7	52.6
Chile	18.3	21	42.3	45.7
Brazil	11.2	9.7	20.2	17.1
Colombia	9.3	5.2	13.1	10.5
Mexico	10.2	9.8	34.7	29.1
South Korea	19.6	22.2	32.6	35.7
South Africa	12.7	12.5	39.1	35.1

1/ Based on external asset positions, as of end-December 2008.

2/ Based on consolidated claims on an immediate borrower basis, as of end-December 2008.

Source: BIS and author's calculations.

Most of the claims on Chile are held by Spanish banks (Table 2). The dominant presence of Spanish banks is explained by the important role played by BBVA and Banco Santander in the Chilean banking system. Between them, the two institutions account for 33 percent of the assets in the banking system, 24 percent of the non-derivatives financial instruments and 40 percent of the notional outstanding amount of gross derivatives positions. Furthermore, due to the scale of its operations, measured in terms of assets, Banco Santander is required to hold regulatory capital in excess of 11 percent compared with 8 percent for other banks.

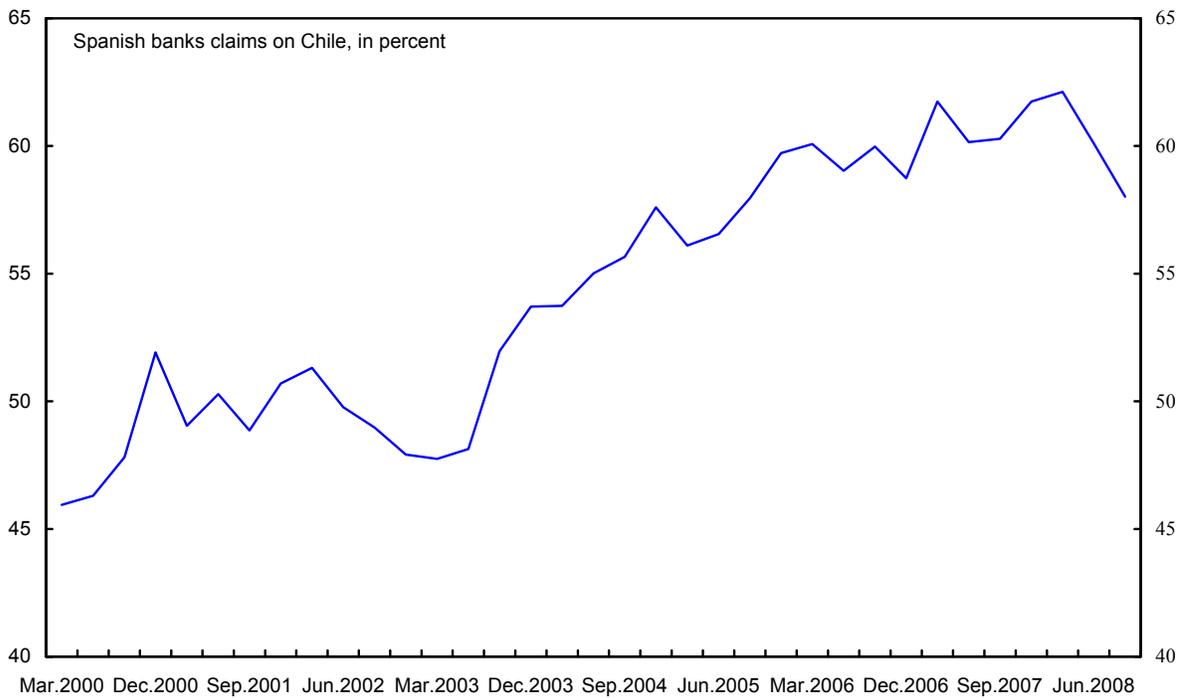
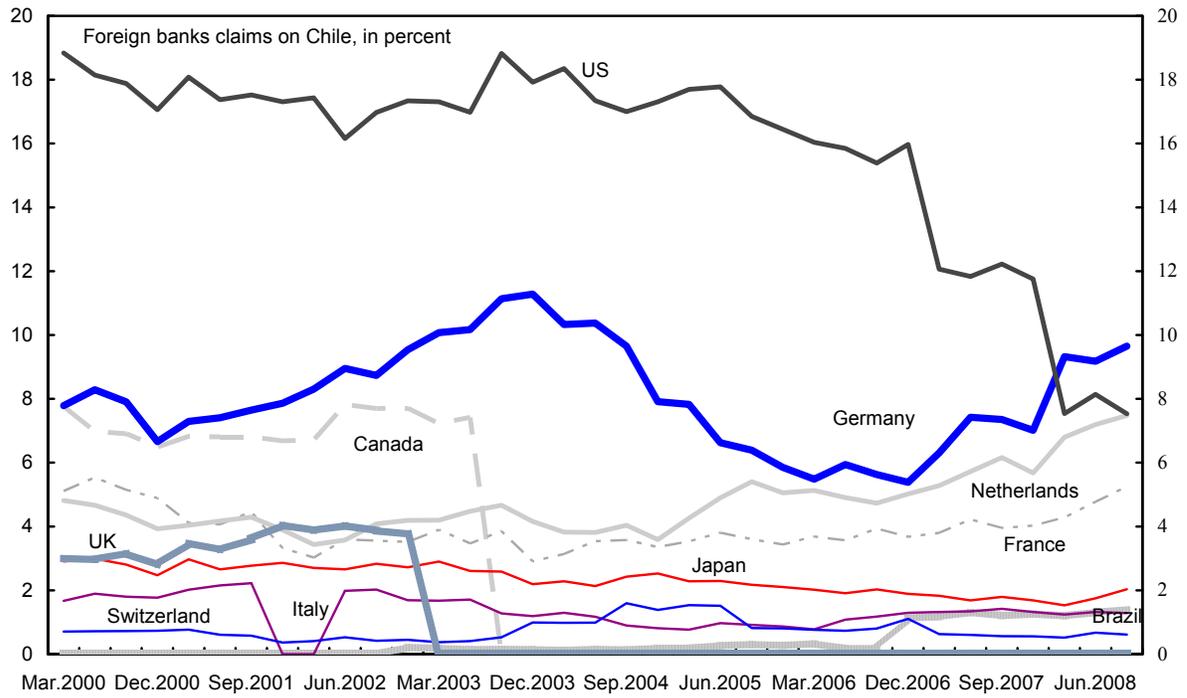
Table 2. Foreign banks' consolidated claims on Chile by nationality
(on an immediate borrower basis)

	2002	2007	2008
Spain	48.0	56.2	52.0
United States	17.4	10.7	6.8
Germany	9.6	6.2	7.8
Netherlands	4.2	5.2	6.1
United Kingdom	3.8	0.0	0.0
Other	17.1	12.1	27.3
Total	100.0	100.0	100.0

Source: BIS and author's calculations

Spanish and U.S. banks have been losing market share to other European banks and unallocated claims have become more important. U.S. bank lending has further declined due to the subprime crisis (Figure 1). Unallocated claims, as share of total claims, are up to 13 percent at end-2008 from 8.9 percent at end-2007. Assessing the risks from these claims it is difficult since their geographic origin is not known.

Figure 1. Chile: foreign bank claims, in percent of total



Source: BIS and author's calculations

Cross-country consolidated claims only offer a partial view on potential cross border vulnerabilities in a country's banking system. In the specific case of Chile, they suggest that the domestic economy and banking system are vulnerable to adverse shocks to the Spanish banking system. On the other hand, claims data suggest Chile should be relatively isolated to adverse shocks to the British and Canadian banking system, since cross-border claims ceased to exist since early 2003.

The claims data, however, may not be sufficient to identify risks associated with "second round effects." In particular, Spanish banks are highly exposed to developments in the British economy since one third of their claims are on the U.K. Similarly, British banks hold one tenth of their claims on Spain. The cross-border claims between Spain and the U.K. creates exposure to the Chilean economy, as shocks in the U.K. will be transmitted via Spanish banks. Similarly, negative shocks to the Chilean economy can be transmitted to the U.K. with Spanish banks serving as conduits. The next section argues how to capture these second round effects using market-based information.

III. ASSESSING THE IMPACT OF THE CRISIS USING MARKET INFORMATION

The assessment of the exposure of banks operating in any given jurisdiction is not a straightforward exercise due to data limitations. Institutional data on cross-market, cross-currency, and cross-country linkages is, at best, not readily available. As the previous section discussed, aggregated consolidated claims data only provides a snapshot into potential cross-country exposures. In addition, the recent crisis has shown that linkages are not restricted exclusively to direct exposures but can arise from indirect channels. One example of such a channel is the homogeneity of banks' balance sheets that make them vulnerable to a mark-to-market shock. In the case of an open economy like Chile, where foreign banks play an important role in intermediating funds, indirect exposures may be more closely associated with the linkages of parent banks with other global financial institutions or the use of similar investment and lending strategies in domestic markets.³

Information from security prices helps to deal with data limitations and imperfect knowledge about exposures across financial institutions. When market prices are available, it is possible to use different econometric and empirical methods to measure the CoRisk or risk codependence across financial institutions while accounting for potential nonlinear effects. This section starts by describing the market-based risk measure used in this study; describes the data used in the analysis, and concludes by explaining how to construct the CoRisk measures using quantile regressions.⁴

³ See Cifuentes, Shin and Ferrucci (2005), Lagunoff and Shreft (2001), and Chan-Lau (2008a) among others.

⁴ In addition to quantile regressions, as done in this study, it is possible to use extreme value theory, and multivariate GARCH and regime switching models.

A. Expected Default Frequency (EDF) Measures

The market-based risk measure used here is the Expected Default Frequency (EDF), a measure reported by Moody's KMV for a worldwide sample of banks and financial institutions. While there are several risk measures based on market information, such as bond or CDS spreads, EDFs offer some advantages over them. Foremost among them is that EDFs are objective or real-world default probabilities. In contrast, default probabilities measures extracted from bond or CDS spreads are risk-neutral and tend to overstate their real-world counterparts due to the presence of a default risk premium.⁵ EDFs also combine both market information from equity prices and the non-market information from the liability side of the balance sheet of the firm. Finally, empirical studies have shown that EDF-like measures can explain default risk in equity returns and forecast financial institutions' failures.⁶

Conceptually, the EDF is based on the distance-to-default.⁷ The distance-to-default measure is built upon the insight that the default of a firm occurs when the asset value of the firm is less than what the firm owes to its debtors. What the firm owes is commonly referred to as the default barrier, and in practice, it is calculated as the face value of short-term liabilities plus half of the face value of long-term liabilities. The wider the gap between the asset value and the default barrier, the safer the firm is. Similarly, the less volatile the asset value is, the safer the firm is since the likelihood of hitting the default barrier diminishes. The distance-to-default, therefore, can be expressed simply as:

$$(1) \quad \text{Distance to Default} = \frac{\text{Market Value of Assets} - \text{Default Barrier}}{\text{Asset Volatility}}$$

The distance-to-default measure can be constructed using information from equity prices and balance sheet information. This information in turn helps to determine the market value of assets and the asset volatility of a firm. For a given firm, Moody's KMV obtains the firm's EDF from its distance-to-default measure from the empirical calibration of various levels of distance-to-default to actual default probabilities based on a proprietary historical database. EDFs, therefore, are equivalent to objective default probabilities and can be associated with credit ratings, as shown in Table 3. The mapping between EDFs and Moody's ratings facilitates comparison with institutions rated by rating agencies but not yet included in Moody's KMV database.

⁵ Berndt et al (2005).

⁶ See Vassalou and Xing (2004) on default risk and equity returns; and Gropp, Vesala and Vulpes (2004) and Chan-Lau, Jobert, and Kong (2004) on using the distance-to-default to forecast bank failures in advanced and emerging market economies respectively.

⁷ Crosbie and Bohn (2003).

Table 3. EDFs and equivalent Moody's credit ratings.

The table shows the equivalence between 5-year EDFs, in percent, and Moody's credit ratings scale

Moody's rating	EDF	Moody's rating	EDF
Aaa	0.02	Ba1	0.408
Aa1	0.032	Ba2	0.544
Aa2	0.04	Ba3	0.848
Aa3	0.056	B1	1.323
A1	0.08	B2	2.064
A2	0.114	B3	4.168
A3	0.144	Caa1	8.418
Baa1	0.182	Caa2	17
Baa2	0.23	Caa3	17.946
Baa3	0.307	Ca, C	20

B. Data

This study uses EDFs to measure the CoRisk induced by Latin American and global financial institutions on their Chilean counterparts. Table 4 shows the financial institutions included in the analysis. In addition to financial institutions operating in Chile, the sample includes financial institutions in Brazil, Colombia, and Peru; and major global banks in Canada, Europe, and the United States.⁸ For each of these institutions, weekly 5-year EDF series were constructed from daily data for the period May 2, 2003 – February 27, 2009.⁹

The analysis includes a subset of Chilean institutions that represent a large share of the systemic core of the banking system. Only six Chilean institutions out of a total of twenty five banks reporting to the Banking Supervisory Agency (SBIF) are included. But as of end-January 2009, the Chilean institutions analyzed accounted for 70 percent of the assets in the banking system, 56 percent of non-derivatives financial instruments positions, and 65 percent of the gross derivatives positions as measured by notional outstanding amounts (SBIF, 2009a, 2009b).¹⁰

⁸ Although it is not correct, institutions operating in a given country will be referred to interchangeably as “the country” or the “country’s institutions” for simplicity.

⁹ 5-year EDFs correspond to the probability that the institution defaults sometime over a 5-year horizon. The choice of the 5-year horizon would facilitate contrasting the results presented herein with studies that use 5-year CDS spreads, the latter being the most liquid CDS traded maturity in the market.

¹⁰ Calculated as the ratio of the sum of derivatives assets and liabilities positions for the banks in the sample to the corresponding total sum for the banking system.

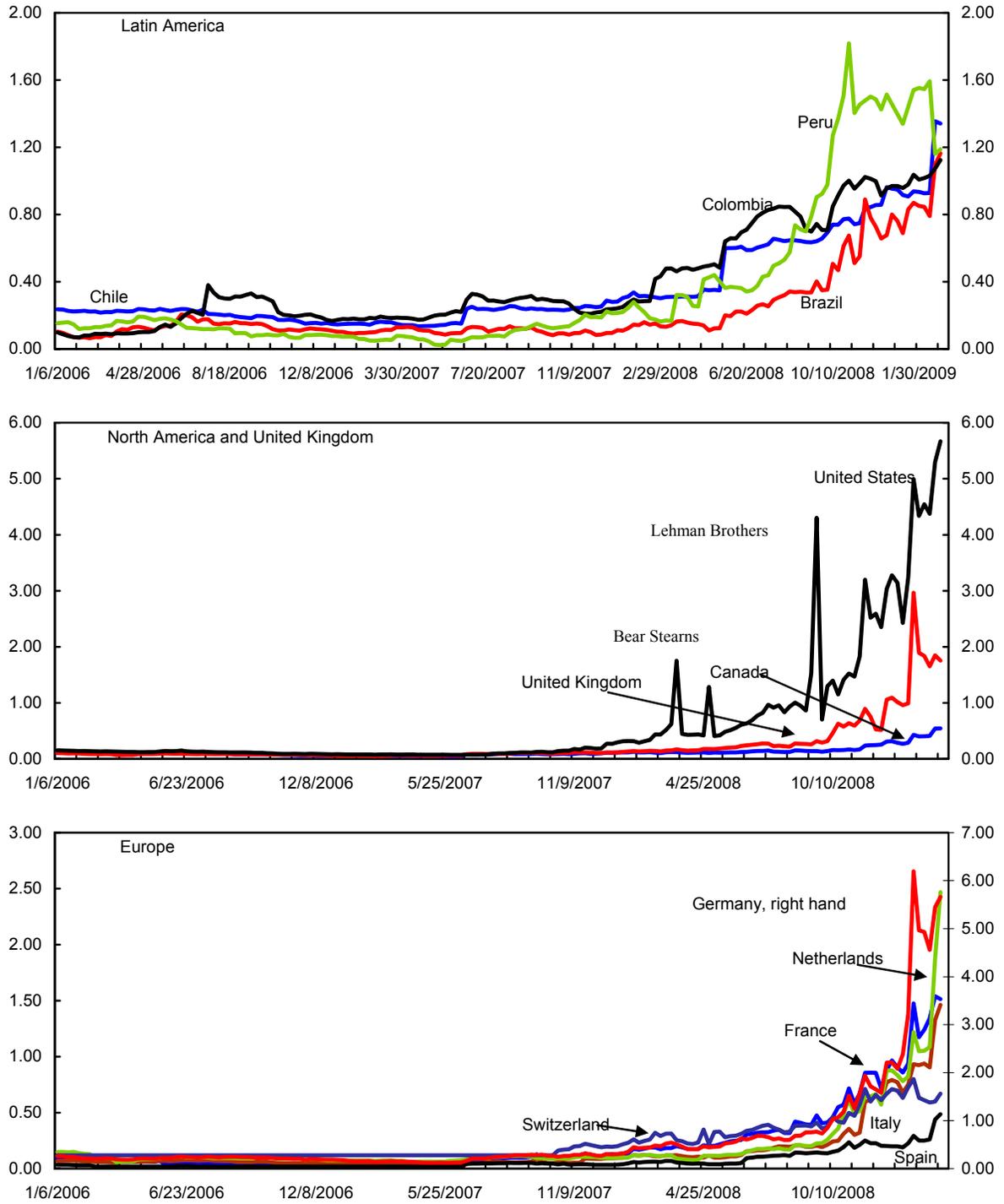
Table 4. Financial institutions included in the analysis.

<i>Chilean institutions</i>	<i>Dutch institutions</i>	<i>Spanish institutions</i>
Scotia Bank Chile	ABN Amro	BBVA
CorpBanca	ING Grope	Banco Santander
Banco de Crédito e Inversiones		
Banco de Chile	<i>French institutions</i>	<i>Swiss institutions</i>
Banco BBVA Chile	Banque Nationale Paribas	Credit Suisse
	Credit Agricole	UBS
	Societe Generale	
<i>Brazilian institutions</i>	<i>German institutions</i>	<i>UK institutions</i>
Banco Bradesco	Commerzbank	HSBC
Banco Itaú	Deutsche Bank	Lloyds
		Royal Bank of Scotland
		Standard Chartered
<i>Colombian institutions</i>	<i>Peruvian institutions</i>	<i>US institutions</i>
Banco BBVA Colombia	Banco Continental	Bank of America
Banco de Bogotá	Banco de Crédito	Morgan Stanley
BanColombia	ScotiaBank Perú	Goldman Sachs
Banco de Occidente		Citigroup
Banco Santander Colombia		Wells Fargo
BanColombia	<i>Italian institutions</i>	JPMorgan
Corporacion Financiera	Banca Intesa	Bear Stearns
Grupo Aval	MedioBanca	Lehman Brothers
	Unicredito	Merrill Lynch
<i>Canadian institutions</i>		Wachovia
Bank of Nova Scotia		JPMorgan
CIBC		
Royal Bank of Canada		

Default risk increased rapidly due to problems in the U.S. banking system. Figure 2 shows how default risk in each country, measured as the average 5-year EDF for the country's banks, has evolved since early 2006.¹¹ In general, EDFs were rather compressed until early 2008 but started widening in 2008 following the failure of Bear Stearns (March 2008), the bankruptcy of Lehman Brothers and the bailout of AIG (September 2008). The data seems to show that the crisis originated in the United States, where EDFs widened earlier than in other countries with the exception of Germany. Note that the German banks included in the sample, as the U.S. institutions, were reportedly important players in the structured credit market. Based on Table 3, at end-February 2009 the average implied rating of US and German institutions was B3 but inching dangerously downwards to Caa1.

¹¹ Some caution is needed when interpreting the figure since the analysis only includes two institutions for some countries.

Figure 2. 5-year EDFs, in percent



Source: Moody's KMV and staff calculations.

Spanish institutions, among European ones, were among the least affected by the crisis. Arguably more conservative lending practices vis-à-vis other European banks, limited or no exposure to structured credit products referred to as “toxic assets” nowadays, and the use of regulatory dynamic provision requirements contributed to partly insulate Spanish banks from the stresses experienced by financial institutions in other countries.

The evolution of default risk in Latin America, where Spanish institutions have a substantial footprint, is rather similar to that of Spain. The average EDF remained in the range of 1 to 1½ percent by end-February 2009. Overall, banks in Latin America have little or no exposure to subprime assets and have small trading books relative to their banking book, which helps to insulate them from market shocks. Among Latin American countries, Chile has been the less affected by the global turmoil. The next section formally analyzes the comovements between individual institutions.

C. Empirical Method: Corisk estimation using Quantile Regressions

Corisk, or risk codependence, can be defined as the increase in the risk of one institution conditional on the risk of a peer institution. While there is no unique nor generally accepted method to measure corisk, this paper uses Corisk analysis, a method based on quantile regressions motivated by the insights of Adrian and Brunnermeier (2008) and introduced in Chan-Lau (2008b).¹²

The basic question to answer is how the default risk of an institution is affected by the default risk of another institution, after controlling for common sources of risk. In statistical terms, the goal is to learn $f(y|x, \theta)$, the conditional distribution of the default risk of institution y , given common drivers of default risk and the default risk of the other institution, which are denoted by x , where θ is a set of parameters that needs to be inferred from observed realizations of x . Ordinary least squares (OLS) is a useful technique to extract this information. However, OLS can only provide information about the *mean* relationship across institutions’ default risk. Because this relationship is non linear, OLS may have some serious limitations.

Quantile regression is an alternative to the use of nonlinear models that can capture some of the non-linearities of the relationship across institutions’ default risk. Quantile regression, first introduced by Koenker and Bassett (1978), extends the OLS intuition beyond the estimation of the mean of the conditional distribution $f(y|x, \theta)$. It allows the researcher to “slice” the conditional distribution at the quantile (percentile) of interest, τ , and obtain the corresponding cross-section of the conditional distribution $f_{\tau}(y|x, \theta)$.

Quantile regression makes possible to evaluate the response of the independent variable on particular segments of the conditional distribution. For instance, when a linear model is used to analyze systemic interlinkages, it is expected that the coefficients of the regressors change

¹² See Chan-Lau, (2009) for further specialization of this framework to the analysis of systemic risk..

with the level of risk. In terms of model estimation, quantile regression does not consist on estimating a number of separate OLS regressions in non-overlapping samples after sorting the data by quantiles (or percentiles) though the use of the term “quantile” may suggest so. Using non-overlapping samples could introduces a small sample problem when dealing with lower and/or higher quantiles of the data, a problem often found when analyzing data with extreme value theory techniques.

Quantile regressions make the best use of all data available in the sample by weighting each available observation. In a quantile regression the parameters are obtained by solving an optimization program that uses all the information contained in the data sample. The parameters are obtained from the minimization of the sum of residuals, $y - x\beta$, where the latter are weighted by a check function, ρ_τ , that depends on the quantile of interest, τ :

$$(3) \quad \min_{\beta} \sum_i^N \rho_\tau(y_i - \xi(x_i, \beta)),$$

where y is the dependent variable, $\xi(x_i, \beta)$ is a linear function of the parameters β and the exogenous variables, x_i , and $\rho_\tau(\cdot)$ is a weighting function for each observation. More specifically, the function assigns a weight equal to the quantile τ if the residual is positive, or a weight equal to $\tau - 1$ if the residual is negative. The minimization can be solved using standard linear programming methods. The covariance matrices are usually estimated using bootstrap techniques and remain valid even if the residuals and explanatory variables are not independent (Koenker, 2005)

For analyzing corisk between Chilean and global banks, the following equation was estimated for τ set equal to the 95th quantile:

$$(4) \quad EDF_i = \alpha_\tau + \sum_k^K \beta_{\tau,i,k} R_k + \beta_{\tau,j} Clean\ EDF_j + \varepsilon_i,$$

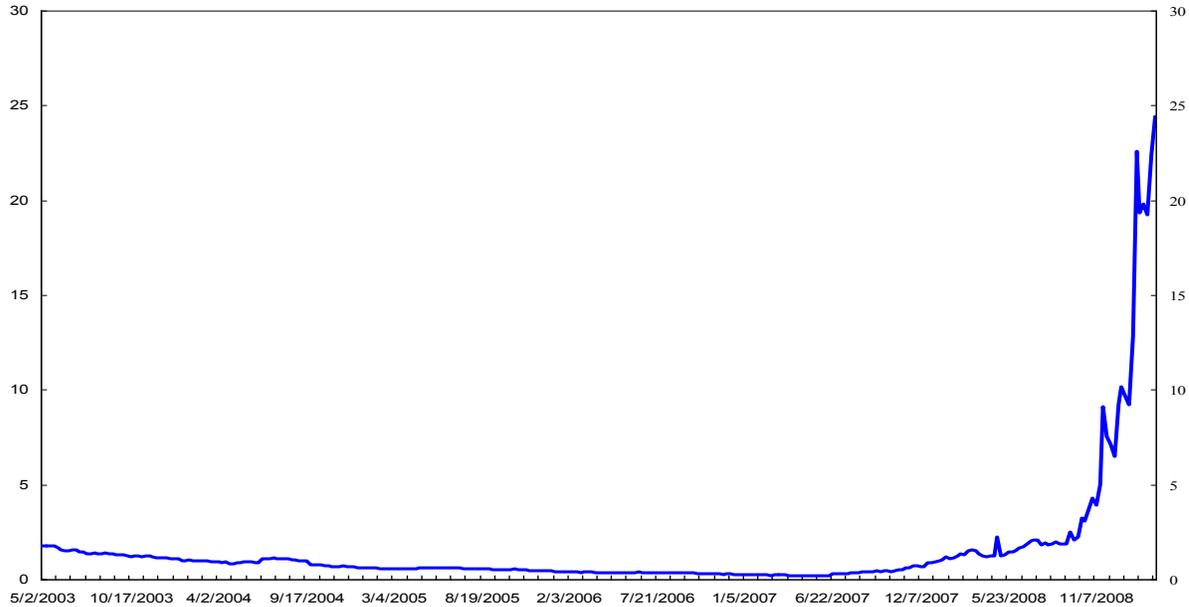
where EDF_i is the EDF of institution i , R_k denotes the k -th common aggregate risk factor, and $Clean\ EDF_j$ is the component of EDF_j that is orthogonal to the common aggregate risk factors R_k 's, which it is referred to here onwards as the orthogonal EDF component. By using the orthogonal component, equation (4) isolates the idiosyncratic effect of institution j on institution i . The fitted values using equation (4) will be referred to as corisk EDF.

Economic theory can be used to guide the choice of aggregate risk factors. Usually, the common risk factors include variables such as the slope of the term structure of interest rates and the implied volatility index (VIX) as a proxy for investor sentiment. The aggregate risk factor in this study, however, was constructed by extracting the main principal components corresponding to the EDFs of all institutions in the sample excluding the Chilean

institutions.¹³ Only the first principal component was included as an aggregate risk factor since it accounted for close to 95 percent of the total variability in the data. Furthermore, as Figure 3 illustrates, the first principal component can be roughly identified with default risk in the global banking system.

Figure 3. Aggregate risk factor

The aggregate risk factor corresponds to the first principal component extracted from the EDFs of all institutions in the sample excluding the Chilean institutions.



IV. RESULTS

Banks in Chile have been mainly affected by aggregate risk in the global financial system and to a lesser extent by idiosyncratic shocks affecting regional and international banks. The impact of changes in aggregate risk can be roughly approximated by the difference between the median EDF and the unconditional EDF measured at the 95th percentile (Table 5). For Chilean banks, the unconditional EDF is two to three times higher than the median EDF. The impact of idiosyncratic shocks can be gauged from the difference between the conditional EDF, or corisk EDF, obtained from equation (4) and the unconditional EDF. The median corisk EDF exceeds the unconditional 95th percentile EDF by 15 to 100 percent, depending on the institution analyzed.

¹³ Principal component analysis is a technique widely used to construct factors. For details, see for instance Timm (2002).

Table 5. Corisk between financial institutions abroad and those operating in Chile, measured as Expected Default Frequency (EDF) (in percent).

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6
Median EDF	0.71	0.12	0.08	0.20	0.12	0.32
95th percentile EDF	2.68	0.24	0.24	0.50	0.23	0.76
<i>Latin American institutions</i>						
Banco Bradesco, Brazil	5.94	0.27	0.31	0.71	0.30	0.91
Banco Itau, Brazil	5.75	0.27	0.30	0.68	0.31	0.88
Banco BBVA Colombia	3.02	0.26	0.23	0.60	0.36	0.86
Banco de Bogotá, Colombia	5.87	0.32	0.30	0.70	0.33	0.83
Banco de Occidente, Colombia	3.51	0.30	0.27	0.59	0.39	0.85
Banco Santander, Colombia	3.84	0.31	0.27	0.55	0.46	0.73
BanColombia, Colombia	5.07	0.27	0.24	0.67	0.36	0.83
Corporacion Financiera, Colombia	5.86	0.27	0.32	0.67	0.35	0.92
Grupo Aval, Colombia	5.52	0.34	0.34	0.70	0.41	0.85
Banco Continental, Perú	5.29	0.32	0.31	0.68	0.31	0.89
Banco de Crédito, Perú	5.30	0.31	0.25	0.68	0.37	0.90
ScotiaBank Peru	5.98	0.37	0.31	0.72	0.20	0.69
<i>Minimum</i>	3.02	0.26	0.23	0.55	0.20	0.69
<i>Median</i>	5.41	0.31	0.30	0.68	0.36	0.85
<i>Maximum</i>	5.98	0.37	0.34	0.72	0.46	0.92
<i>U.S. Institutions</i>						
Bank of America	2.89	0.43	0.31	0.73	0.58	0.62
Morgan Stanley	4.02	0.31	0.31	0.68	0.33	0.90
Goldman Sachs	5.52	0.32	0.29	0.66	0.37	0.91
Citigroup	6.50	0.44	0.46	0.94	0.56	0.87
Wells Fargo	3.70	0.32	0.25	0.54	0.35	0.79
Bear Stearns	5.42	0.26	0.24	0.68	0.37	0.80
Lehman Brothers	6.14	0.43	0.42	0.76	0.45	1.01
Merrill Lynch	6.25	0.37	0.39	0.79	0.51	0.92
Wachovia	4.52	0.25	0.17	0.65	0.38	0.85
JP Morgan	5.44	0.32	0.34	0.69	0.35	0.88
<i>Minimum</i>	2.89	0.25	0.17	0.54	0.33	0.62
<i>Median</i>	5.43	0.32	0.31	0.69	0.38	0.88
<i>Maximum</i>	6.50	0.44	0.46	0.94	0.58	1.01
<i>Canadian institutions</i>						
Bank of Nova Scotia	3.44	0.34	0.29	0.54	0.31	0.80
CIB	3.33	0.40	0.35	0.55	0.37	0.84
Royal Bank of Canada	5.58	0.26	0.24	0.68	0.38	0.78
<i>Minimum</i>	3.33	0.26	0.24	0.54	0.31	0.78
<i>Median</i>	3.44	0.34	0.29	0.55	0.37	0.80
<i>Maximum</i>	5.58	0.40	0.35	0.68	0.38	0.84
<i>European institutions</i>						
BBVA Spain	4.44	0.28	0.20	0.52	0.39	0.88
Banco Santander, Spain	4.25	0.29	0.28	0.56	0.37	0.92
Banque Nationale Paribas, France	3.82	0.33	0.29	0.59	0.30	0.89
Credit Agricole, France	5.73	0.28	0.33	0.69	0.39	0.89
Societe Generale, France	5.55	0.27	0.30	0.70	0.33	0.89
Commerzbank, Germany	6.08	0.27	0.33	0.72	0.30	0.91
Deutsche Bank, Germany	5.96	0.32	0.31	0.72	0.31	0.92
Banca Intesa, Italy	5.90	0.29	0.31	0.70	0.26	0.87
Mediobanca, Italy	5.99	0.29	0.32	0.70	0.30	0.90
Unicredito, Italy	5.54	0.30	0.31	0.70	0.42	0.87
Credit Suisse, Switzerland	5.51	0.29	0.19	0.60	0.19	0.84
UBS, Switzerland	4.49	0.32	0.27	0.71	0.35	0.84
Barclays, United Kingdom	3.73	0.31	0.28	0.63	0.38	0.84
HSBC, United Kingdom	4.29	0.31	0.28	0.62	0.37	0.86
Lloyds, United Kingdom	5.51	0.26	0.26	0.58	0.29	0.91
Royal Bank of Scotland, United Kingdom	4.41	0.36	0.31	0.62	0.36	0.84
Standard Chartered, United Kingdom	3.71	0.26	0.20	0.68	0.37	0.80
ABN Amro, Netherlands	4.24	0.27	0.20	0.68	0.37	0.87
ING, Netherlands	3.49	0.31	0.27	0.60	0.32	0.88
<i>Minimum</i>	3.49	0.26	0.19	0.52	0.19	0.80
<i>Median</i>	4.49	0.29	0.28	0.68	0.35	0.88
<i>Maximum</i>	6.08	0.36	0.33	0.72	0.42	0.92

Source: Moody's KMV and staff calculations.

Bank vulnerability to adverse idiosyncratic shocks affecting other banks seems related to leverage, external debt and/or obligations, and the strength of the parent institution in the case of foreign-owned banks. Higher unconditional and corisk EDFs are associated with highly levered banks and those with high external debt ratios, where the latter are measured as debt owed to foreign banks. When the corisk EDF is measured as percent changes vis-à-vis the unconditional EDF, Banks 1 and 5 are the two institutions most affected by institution-specific shocks.

Changes in implied ratings also highlight the relative importance of aggregate shocks vis-à-vis bank-idiosyncratic shocks. Table 6 shows the Moody's 5-year credit ratings implied by the corisk and unconditional EDFs according to the mapping reported in Table 3.¹⁴ Compared to the median rating, the unconditional 95th percentile EDF implies a downgrade of three to four notches which can be attributed to the aggregate shock. In contrast, idiosyncratic shocks to foreign institutions induce, on average, at most one conditional rating downgrade on Chilean institutions from the rating implied by its unconditional 95th percentile EDF.

There are second-round effects that affect the Chilean banking system even in the absence of reported cross-border banking claims. For instance, since 2003 there have been no cross-border claims between Chile and the United Kingdom. Shocks affecting British banks, however, cause a one rating conditional downgrade in Chilean banks. This is also true, to a lesser extent, in the case of Canadian banks. Put together, these results suggest how information on direct exposures, such as consolidated claims, and market-based information, such as EDFs, complement each other and are useful for assessing risks in the financial sector.

Although Chilean banks are vulnerable to aggregate financial shocks, several factors may have contributed to make them relatively resilient to institution-specific shocks. First, reliance on external financing sources is limited since the domestic banking system fund their operations mainly through domestic deposits (60 percent of assets), and by issuing domestic securities (13 percent of assets) while external funding is small (5 percent of assets).¹⁵

¹⁴ The reader should keep in mind that the ratings movements are those implied by the changes in the EDFs (or probabilities of default). Therefore, the analysis does not refer to actual upgrades or downgrades by credit rating agencies.

¹⁵ Figures in this section estimated using publicly available data from the Superintendencia de Bancos e Instituciones Financieras Chile (SBIF).

Table 6. Corisk between financial institutions abroad and those operating in Chile, measured as Moody's credit ratings.

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6
Median rating	Ba2	A2	Aa3	Baa1	A2	Baa3
Unconditional rating, 95th percentile	B2	Baa2	Baa2	Ba1	Baa2	Ba2
<i>Latin American institutions</i>						
Banco Bradesco, Brazil	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Banco Itau, Brazil	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Banco BBVA Colombia	B2	Baa2	Baa1	Ba2	Baa3	Ba3
Banco de Bogotá, Colombia	B3	Baa3	Baa2	Ba2	Baa3	Ba2
Banco de Occidente, Colombia	B2	Baa2	Baa2	Ba2	Baa3	Ba3
Banco Santander, Colombia	B2	Baa3	Baa2	Ba2	Ba1	Ba2
BanColombia, Colombia	B3	Baa2	Baa2	Ba2	Baa3	Ba2
Corporacion Financiera, Colombia	B3	Baa2	Baa3	Ba2	Baa3	Ba3
Grupo Aval, Colombia	B3	Baa3	Baa3	Ba2	Ba1	Ba3
Banco Continental, Perú	B3	Baa3	Baa3	Ba2	Baa3	Ba3
Banco de Crédito, Perú	B3	Baa3	Baa2	Ba2	Baa3	Ba3
ScotiaBank Peru	B3	Baa3	Baa3	Ba2	Baa1	Ba2
Minimum	B2	Baa2	Baa1	Ba2	Baa1	Ba2
Median	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Maximum	B3	Baa3	Baa3	Ba2	Ba1	Ba3
<i>U.S. Institutions</i>						
Bank of America	B2	Ba1	Baa2	Ba2	Ba2	Ba2
Morgan Stanley	B2	Baa2	Baa2	Ba2	Baa3	Ba3
Goldman Sachs	B3	Baa3	Baa2	Ba2	Baa3	Ba3
Citigroup	B3	Ba1	Ba1	Ba3	Ba2	Ba3
Wells Fargo	B2	Baa3	Baa2	Ba2	Baa3	Ba2
Bear Stearns	B3	Baa2	Baa2	Ba2	Baa3	Ba2
Lehman Brothers	B3	Ba1	Ba1	Ba2	Ba1	Ba3
Merrill Lynch	B3	Baa3	Baa3	Ba2	Ba1	Ba3
Wachovia	B3	Baa2	A3	Ba2	Baa3	Ba3
JP Morgan	B3	Baa3	Baa3	Ba2	Baa3	Ba3
Minimum	B2	Baa2	A3	Ba2	Baa3	Ba2
Median	B3	Baa3	Baa2	Ba2	Baa3	Ba3
Maximum	B3	Ba1	Ba1	Ba3	Ba2	Ba3
<i>Canadian institutions</i>						
Bank of Nova Scotia	B2	Baa3	Baa2	Ba1	Baa2	Ba2
CIB	B2	Baa3	Baa3	Ba2	Baa3	Ba2
Royal Bank of Canada	B3	Baa2	Baa2	Ba2	Baa3	Ba2
Minimum	B2	Baa2	Baa2	Ba1	Baa2	Ba2
Median	B2	Baa3	Baa2	Ba2	Baa3	Ba2
Maximum	B3	Baa3	Baa3	Ba2	Baa3	Ba2
<i>European institutions</i>						
BBVA Spain	B3	Baa2	Baa1	Ba1	Baa3	Ba3
Banco Santander, Spain	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Banque Nationale Paribas, France	B2	Baa3	Baa2	Ba2	Baa2	Ba3
Credit Agricole, France	B3	Baa2	Baa3	Ba2	Baa3	Ba3
Societe Generale, France	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Commerzbank, Germany	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Deutsche Bank, Germany	B3	Baa3	Baa3	Ba2	Baa2	Ba3
Banca Intesa, Italy	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Mediobanca, Italy	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Unicredito, Italy	B3	Baa2	Baa3	Ba2	Ba1	Ba3
Credit Suisse, Switzerland	B3	Baa2	Baa1	Ba2	Baa1	Ba2
UBS, Switzerland	B3	Baa3	Baa2	Ba2	Baa3	Ba2
Barclays, United Kingdom	B2	Baa3	Baa2	Ba2	Baa3	Ba2
HSBC, United Kingdom	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Lloyds, United Kingdom	B3	Baa2	Baa2	Ba2	Baa2	Ba3
Royal Bank of Scotland, United Kingdom	B3	Baa3	Baa3	Ba2	Baa3	Ba2
Standard Chartered, United Kingdom	B2	Baa2	Baa1	Ba2	Baa3	Ba2
ABN Amro, Netherlands	B3	Baa2	Baa1	Ba2	Baa3	Ba3
ING, Netherlands	B2	Baa3	Baa2	Ba2	Baa3	Ba3
Minimum	B2	Baa2	Baa1	Ba1	Baa1	Ba2
Median	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Maximum	B3	Baa3	Baa3	Ba2	Ba1	Ba3

Source: Moody's KMV and staff calculations.

Domestic funding, however, may be affected negatively going forward. Retail funding is being eroded by increased equity investment and the emergence of alternative investment vehicles targeted to retail customer such as pension funds. Increased investment abroad by pension funds following the relaxation of foreign investment limits has gradually reduced the domestic investor base for bank securities (Saldía et al, 2008). These trends may foster increased external financing, and as the results show, lead to higher exposure to foreign banks' idiosyncratic shocks.

Second, market risk in the system is limited. The trading book, mostly in government securities, accounted for 4 to 5½ percent of assets, and securities available for sale for 7 to 8 percent of assets. While derivatives are mostly held for trading purposes, the net open position in the system was at most 1½ percent of assets during the period. Furthermore, derivatives trading mainly involves trading forward and swaps, so notional amounts may certainly overstate losses due to market risk. A back of the envelope calculation suggests that at most 13 percent of assets are directly affected by market risk.

Third, credit risk remains the main source of vulnerability in the banking system. Banks, hence, are somewhat insulated from problems affecting other banks since credit risk is predominantly driven by developments in the domestic economy. According to aggregate balance sheet data, the banking book usually accounts for 67 percent of the assets in the banking system. Vulnerabilities, hence, are more likely to arise from the deterioration of creditworthiness in the corporate and household sectors.

Finally, counterparty risk within the domestic system appears limited and reduces exposures to international institutions through second-round effects channels. Counterparty exposure can be roughly estimated as the sum of the trading exposure (4 to 5½ percent of assets), interbank lending (less than ½ percent of assets), and derivatives net open positions (1½ percent of assets). The reduced counterparty exposure translates into limited corisk exposure within Chilean banks, with banks experiencing at most a one ratings downgrade conditional on other banks' increase in default risk (Table 7).

Table 7. Corisk between Chilean banking institutions, measured as Expected Default Frequency and implied Moody's ratings.

The table reports corisk measured as the EDF and rating of banks listed in the upper row conditional on the EDF and rating of the banks listed in the first column.

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6
Median EDF	0.71	0.12	0.08	0.20	0.12	0.32
95th percentile EDF	2.68	0.24	0.24	0.50	0.23	0.76
Bank 1		0.30	0.26	0.55	0.36	0.81
Bank 2	5.41		0.26	0.60	0.32	0.90
Bank 3	3.46	0.33		0.57	0.35	0.84
Bank 4	3.98	0.33	0.27		0.37	0.80
Bank 5	3.73	0.33	0.28	0.58		0.81
Bank 6	4.66	0.32	0.31	0.62	0.38	
<i>Minimum</i>	3.46	0.30	0.26	0.55	0.32	0.80
<i>Median</i>	3.98	0.33	0.27	0.58	0.36	0.81
<i>Maximum</i>	5.41	0.33	0.31	0.62	0.38	0.90
Median rating	Ba2	A2	Aa3	Baa1	A2	Baa3
Unconditional rating, 95th percentile	B2	Baa2	Baa2	Ba1	Baa2	Ba2
Bank 1		Baa2	Baa2	Ba2	Baa3	Ba2
Bank 2	B3		Baa2	Ba2	Baa3	Ba3
Bank 3	B2	Baa3		Ba2	Baa3	Ba2
Bank 4	B2	Baa3	Baa2		Baa3	Ba2
Bank 5	B2	Baa3	Baa2	Ba2		Ba2
Bank 6	B3	Baa3	Baa2	Ba2	Baa3	
<i>Minimum</i>	B2	Baa2	Baa2	Ba2	Baa3	Ba2
<i>Median</i>	B2	Baa3	Baa2	Ba2	Baa3	Ba2
<i>Maximum</i>	B3	Baa3	Baa2	Ba2	Baa3	Ba3

Source: Moody's KMV and author's calculations.

V. CONCLUSIONS

Nowadays, domestic banking systems are highly interconnected with the global financial system. The often quoted phrase, "*No man is an island, entire of itself...any man's death diminishes me...*" rings true in light of the increased globalization and rapid pace of innovation experienced in the international financial system.¹⁶

The corisk analysis has shown that, even in the absence of direct exposures with other countries in the region, the domestic banking system in Chile is vulnerable to adverse idiosyncratic shocks affecting other banks in the region as well as in advanced economies. The empirical evidence on the interconnectedness between the domestic banking system and the global banking system makes imperative continue advancing the agenda on cross-border supervision and coordinated crisis management with countries in the region and advanced economies.

Notwithstanding the large presence of foreign-owned institutions and spillover risks, it is worth noting the resilience of the system to idiosyncratic shocks. The magnitude of the

¹⁶ John Donne, 1624, *Devotions Upon Emergent Occasions, Meditation XVII*.

institution-specific spillovers is relatively constrained as adverse shocks abroad translate, at most, into an implied one rating downgrade for most institutions after accounting for aggregate shocks. Nevertheless, some caution is warranted since increased perceptions of risk can cause substantial increases in funding rates to domestic banks or lead to a loss of confidence by depositors.

Although a formal analysis was not conducted, measures enacted by the government may have contributed to offset the surge in risk in the banking system. These measures include the increased flexibility of reserve requirements, swap lines, as well as government auctions of foreign currency denominated deposits for domestic banks. Indeed, as Figure 2 shows, the passage and implementation of the measures kept the average EDF in Chile mostly flat during most of the second half of 2008.

The analysis provides some support to the recommendation by the Financial Advisory Committee to make domestic banks be eligible for SWF deposits. Despite the spillover effects, the corisk analysis finds that Chilean institutions may be less vulnerable than banks abroad, especially those in advanced economies. Nevertheless, empirical analysis can only offer so much support especially since it did not consider a number of relevant factors and alternatives. For instance, deposits with domestic banks may lead to “Dutch disease” problems. Also, the recommendation should be balanced against the alternative to invest in riskless assets, such as government bonds and bills. Finally, in the specific case of foreign owned institutions, it is necessary to ensure that the domestic subsidiaries are effectively ring-fenced from weaker parent institutions to prevent the latter from draining resources from their subsidiaries.

Finally, going forward, risks in the domestic banking system may be more closely associated with credit risk in the household and corporate sectors rather than risk spillovers from the global financial system. Government support and intervention in the banking sector in advanced economies have helped stabilize the financial system and ease the liquidity problems experienced in the second half of 2008. Spillover risks from the financial system appear contained and have been reflected by a decline in the EDFs of Chilean banks from the high levels observed at end-February 2009, where the sample data ends, to values closer to their median levels. This development suggests that in the short and medium term, bank vulnerabilities Chile are more closely associated to stress scenarios that could affect the banks’ loan portfolio.

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